AIR-LAUNCHED TARGET SYSTEM CONCEPT NMD TESTING

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1.0 ABSTRACT

National Missile Defense (NMD) targets are essential for system certification. However, current targets have strategic ballistic missile heritage and require fixed land-based facilities for launch operations. In addition, the target mission profile is further constrained by range safety requirements, limited ground data acquisition resources and treaty constraints. The result is a test scenario with a target launch from a known point with a predictable flight profile.

The development of a complementary mobile air-launched target system that provides increased flexibility will enhance operational testing. The Target Launch System (TLS) concept includes Target Launch Vehicle (TLV), Carrier Aircraft (CA) and Ground Support (GS). TLS concept components were evaluated against program requirements for reliability, threat representation, treaty constraints, operational flexibility, and range restrictions.

The selected NMD TLS uses an air-launched, three-stage TLV operating with existing facility and range assets. The selected concept complies with key NMD test requirements while accommodating range restrictions and treaty constraints. The mobility of the air-launched target will complement ground-based systems and fully stress the NMD system architecture. This is a notional target launch system that has not yet been endorsed by the NMD Joint Program Office (JPO).

2.0 BACKGROUND

Current targets planned for NMD testing are a critical part of an effective architecture certification test program. They fly long-range trajectories and perform high fidelity post-boost payload deployments. However, these targets are ground launched and require fixed infrastructure for their operations. In addition, Kwajalein Missile Range (KMR) is the only range safety approved intercept area and treaty compliant launch location. These constraints result in a known point-to-point trajectory and easily derived flight time for the missile defense architecture to exploit during boost-phase and midcourse phases. Detection assets can be committed to a single launch point without concern for missing initial acquisition. In addition, tracking radar can predict the target flight path after initial detection. Finally, the interceptor crews can determine when the target will have to be engaged instantly after initial detection based on the fixed distance.

Since the test fidelity cannot be increased by moving the intercept area, the only method of reducing NMD exploitation opportunities is to develop a capability for target launch point mobility. The recommended solution is to develop a TLS which can move the launch point as necessary to meet NMD test objectives while operating within constraints. The TLV has to be launched from multiple locations and comply with NMD program test requirements. The TLV must have the ability to support signature and intercept missions in a single test to include Reentry Vehicle (RV) maneuvers. This capability would require the detection and tracking assets to react to a threat from an unknown location arriving at an unknown time. These limitations do not obviate the need for ground based test assets, but identifies a requirement for complementary flexible targets with varying boost-phase trajectories.

The NMD Test and Evaluation Master Plan (TEMP) concludes that the system performance evaluation will be incomplete without a flight test program that uses multiple targets. The TLS will be used as part of a multiple engagement with existing ground based targets launches to fully challenge the NMD system architecture.

3.0 SCOPE AND APPROACH

3.1 Program Scope

The NMD TLS consists of: the Target Launch Vehicle (TLV), Carrier Aircraft (CA), and Ground Support (GS). The TLV flies a pre-programmed flight profile where it deploys payloads and RVs. The CA is a specially modified aircraft which will carry the TLV to remote staging locations or the launch point. The GS includes facility support for the TLV and CA, as well as range support for transport and launch operations.

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3.2 TLS System Design

The system design was based on boost phase (flight profile), and post-boost (payload deployment) derived requirements. Multiple NMD test support mission scenarios were established to determine TLV boost-phase distance, reentry angle, and speed requirements. Existing ground-launched target requirements were used to quantify post-boost requirements including payload mass and volume, number of payload separation events, booster/payload separation velocity, and re-radiation attitude.

TLS segments were selected based on compliance with derived requirements. First, TLV booster propulsion system configurations were evaluated to meet range, reentry, and speed requirements for the required payload mass. Next, a liquid stage propulsion system was sized using booster dispersions, booster/payload separation, and RV maneuvering propulsion requirements. Finally, individual payload deployment maneuvers and telemetry acquisition attitude requirements were used to determine the Reaction Control System (RCS) design. The CA and GS components were developed in support of the selected TLV to complete the TLS Design.

3.3 TLS Operations Concept

An operations concept was then developed for the selected TLS design to comply with the selected mission scenarios. The CA captive flight operations were established to comply with required TLV transport and launch locations. The GS facility and range operations were developed in support of TLV and CA ground testing and flight profiles.

4.0 MISSION SCENARIOS

Five mission scenarios were selected to provide support for high fidelity NMD testing using proposed TLS capabilities and existing ground-based target systems:

A. Single Launch for Intercept
   1. Launch west of California
   2. Launch south of Alaska
B. Multiple Engagement for Intercept
   1. Launch west of California
   2. Launch south of Alaska
C. Signature Acquisition Mission

The scenarios were used to establish candidate launch points and intercept locations and determine the facilities and range infrastructure necessary to execute the missions.

- Launch Point #1 - Pacific Ocean west of California (36 deg N, 237 deg E)
- Launch Point #2 - Pacific Ocean south of Alaska (58 deg N, 205 deg E)

The TLV flight trajectory terminates at the KMR for all intercept missions due to range safety (debris cloud) and interceptor launch point treaty constraints. The TLS shall target so the RVs pass through the intercept location:

- Latitude - 14.9061 deg N (± .02 deg)
- Longitude - 169.5189 deg E (± .02 deg)
- Altitude - 230 km

Desired 3σ tolerances are based on a nominal flight trajectory. The TLV flight trajectory for the single radar signature mission does not require an interceptor and will terminate flight in the Pacific Ocean west of California. The selected launch points and intercept locations establish the TLV ranges necessary to deploy the target at a range of reentry angles for a fixed payload weight. Section 7.0 includes operations concepts for the selected TLS for each of the mission scenarios.

5.0 TLS REQUIREMENTS

TLS requirements are divided into five major areas: mission assurance, threat representation, treaty compliance, operational flexibility, and range restrictions.

5.1 Mission Assurance

Mission assurance comprises system reliability and availability. The TLS must have a calculated system reliability of 95% after CA takeoff through TLV payload and RV deployment. In addition, the TLS must be available to launch the TLV 80% of the time the CA reaches its launch point. This goal is to prevent personnel and asset cost increases due to failure of the TLS to support the test on schedule.

5.2 Threat Representation

Threat representation consists of TLV flight profile (boost and midcourse phase) and payload deployment (reentry phase). The flight profile requirements consist of the capability of the TLV booster to deploy the required payload/RV mass and volume into the required area. The payload deployment scope includes the TLV deployment of the payloads/RV and real-time data and video transmission.

5.2.1 Flight Profile

The TLS will be able to launch the TLV from both mission scenario launch points to the fixed intercept area. Once launched, the TLV trajectory must meet the distance requirements to KMR from the Alaska launch point (5,618 km) and from the California launch point (7,317 km) with a minimum of 850 lbm payload mass at reentry angles of 20 to 40 deg with a speed goal of 7.0 km/sec. In addition, the TLV will provide volume, mechanical, and electrical interfaces as part of the payload interface requirement. Finally, the TLV must provide for a separation velocity of 50 ft/sec from the payload/RV prior to initiation of deployment maneuvers.

5.2.2 Payload Deployment

The TLV shall be able to perform a series of specified attitude maneuvers and initiate commands to deploy multiple payloads to create a particular threat pattern. Each mission will have unique requirements, but the TLV shall have the capability to perform maneuvers (pitch, yaw, roll) and initiate commands to deploy 30 individual payloads. The TLV must also have the capability to keep the payload suite pointed to within 10 degrees of the deployed pattern and reradiate video and telemetry data real-time to the ground range assets. The TLV must also be able to maneuver through multiple RV deployments during reentry.

5.3 Treaty Compliance

Treaty compliance requires recognition of Anti-Ballistic Missile (ABM), Intermediate-Range Nuclear Forces (INF), and Strategic Arms Reduction Treaty (START) considerations applicable to long-range missile defense tests. The ABM treaty constrains the interceptor launch site to either KMR or White Sands Missile Range (WSMR). Since WSMR does not have the range capability to support NMD testing, all interceptor launches and intercepts will occur within the KMR.

START requires air-launched targets with ranges greater than 600 km to have an aerodynamic surface that provides lift to sustain flight over its flight path. The INF treaty requires monitoring and inspection for booster configurations used as ballistic missiles.

5.4 Operational Flexibility

TLS compliance with this requirement is necessary to ensure the NMD architecture is effectively challenged for final system certification. The TLS must have the ability to launch the TLV from multiple launch points to properly evaluate detection asset launch acquisition responsiveness and accuracy. In addition, the TLS must also provide multiple reentry angles to prevent tracking assets from easily predicting the midcourse TLV location along the flight path. Finally, the TLS must launch the TLV in closer proximity to the intercept location than a ground launch vehicle to further challenge the architecture by varying response time.

5.5 Range Restrictions

The TLS must comply with range restrictions concerning TLV boost-phase flight profile and intercept point accuracy. The TLV Flight Termination System (FTS) must receive range safety certification by the US government lead test range personnel. In addition, the flight profile must also comply with range safety overflight requirements and provide visibility for payload deployment re-radiation and TLV performance reconstruction data. Finally the TLV nominal flight profile analysis must show the vehicle flying into the fixed intercept location within ± .02 deg to meet the debris cloud prediction requirements.

6.0 TLS VEHICLE SELECTION RESULTS

Each TLS segment was evaluated against the requirements in Section 5.0.

6.1 TLV

The TLV is a winged, three stage booster which weighs approximately 22,680 kg (50,000 lbm), measures 16.9 m (55.4 ft) in length and 1.27 m (50 in) in diameter, and has a wing span of 6.7 m (22 ft). The TLV is depicted in *Figure 1*. The vehicle is designed to be carried via CA for transport and launch operations. The vehicle's autonomous guidance and flight control system can deploy payloads and RVs for a variety of missile defense tests. Each TLV element was selected based on requirements evaluation. The TLV incorporates six major elements:

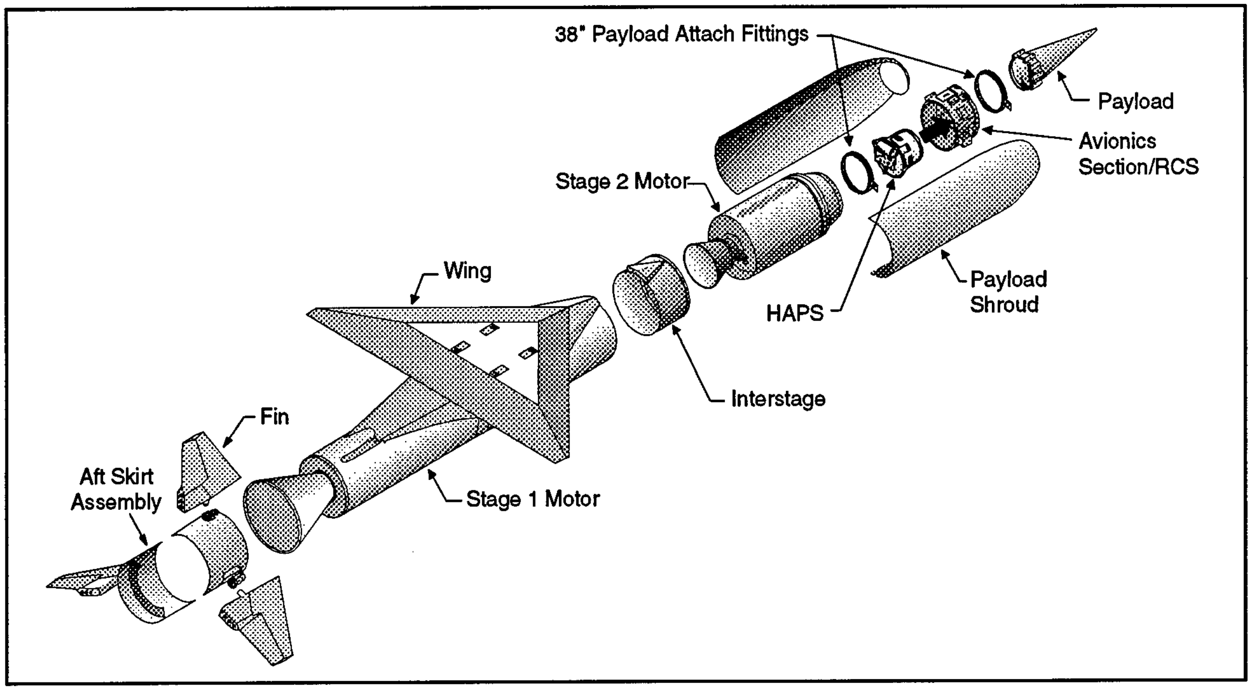


Figure 1. Expanded View of TLV.

- Solid Rocket Motors (Stage 1 and 2)
- Liquid Stage/Reaction Control System (Stg 3)
- Payload Shroud
- Wing
- Avionics System
- Aft Skirt Assembly/Fins

The reliability for the selected TLV is 97.22% which complies with the 95% reliability requirement (*Figure 2*). The demonstrated availability of the TLV is 85% and complies with the 80% requirement. *Figure 3* shows the TLV compliance summary.

Requirement	X	Comments
1. Mission Assurance	X	• Availability and Reliability Compliance • Pegasus Design and Flight Heritage
2. Threat Representation	X	• Complies with 850 lb at 20, 30 deg Reentry Angles; 40 deg Alaska Only • Deploys 30 Payloads/RVs and Transmits TLM
3. Treaty Compliance	X	• Wing for Stage 1 Boost Phase Aerodynamic Lift • Not Ballistic Missile Configuration
4. Operational Flexibility	X	• Air Launched
5. Range Restrictions	X	• FTS Range Safety System Undergoing Certification • Velocity Adjust to Target Aimpoint

Figure 3. TLV Requirements.

6.1.1 Solid Rocket Motors (Stage 1/2)

A series of two and three-stage configurations were evaluated against program performance requirements. Two two-stage and two three-stage configurations with air-launch capability were selected for further evaluation. The two three-stage configurations were eliminated due to significant payload volume limitations and high program development risk to gain increased performance that is not required. The two configurations remaining were the Orion 50/50S and Orion 50XL/50SX. Next, the performance of these candidate configurations was evaluated using modified Three Degree of Freedom (3DOF) flight profile analyses.

Two Solid Rocket Motors (XL Stage 1/2)	0.98654
Third Stage (HAPS and RCS)	0.99724
Payload Fairing	0.99980
Wing	1.00000
Avionics	0.98865
Aft Skirt/Fins	0.99977
Total System	0.9722

Figure 2. TLV Reliability.

As shown in *Figure 4*, for an 850 lb payload, the maximum range capability for the Orion 50/50S from the California launch point is 5,451 km (33.29 degree reentry angle), significantly less than the required distance to KMR (7,317 km).

As shown in *Figure 5*, for an 850 lb payload, the minimum range capability for the Orion 50XL/50SXL from the California launch point is 6,929 km at 40 degree

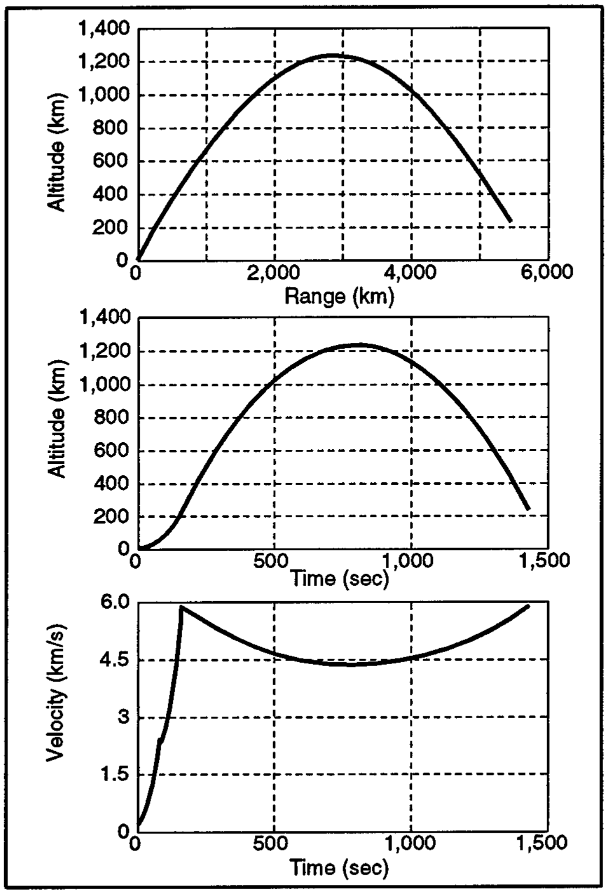
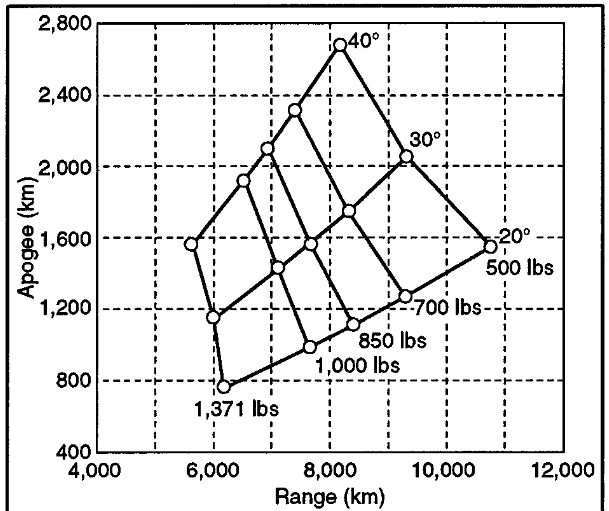


Figure 4. Orion 50/50S Performance for 850 lbm Payload.



Payload (lbs)	Burnout Flight Path Angle (deg)	Range (km)	Apogee (km)
1,371	20	6,175	756
1,371	30	5,991	1,140
1,371	40	5,640	1,561
1,000	20	7,624	980
1,000	30	7,098	1,416
1,000	40	6,505	1,920
850	20	8,385	1,107
850	30	7,657	1,564
850	40	6,929	2,094
700	20	9,283	1,265
700	30	8,299	1,744
700	40	7,407	2,314
500	20	10,750	1,548
500	30	9,318	2,051
500	40	8,146	2,681

Figure 5. Orion 50XL/50SXL Range and Apogee vs. Burnout Flight Path Angle and Payload Weight.

reentry angle which does not meet the 7,317 requirement. However, the TLV easily meets the 20 and 30 degree reentry angle performance requirements and all flight profiles from Alaska (5,618 km). Therefore, the selected TLV booster configuration is the Orion 50XL/50SXL due to its superior range capability for a baseline 850 lbm payload.

The Orion 50XL/50SXL provides a range of 7657 km for the 850 lbm payload at a reentry angle of 30 degrees. The TLV will reach a maximum altitude of 1,564 km and reentry speed of 6.9 km/sec. The altitude and range will vary based on the selected reentry angle for the fixed payload requirement with the speed approaching the 7.0 km/sec goal for every scenario (see *Figure 6*).

The selected booster configuration relies heavily on Pegasus® space launch vehicle heritage as the two solid motors make up two of the three Pegasus solid stages. The motors have a 100% success record over thirteen launches and have a two-year backlog to ensure motor availability.

The remainder of the TLV booster configuration consists of a wing attached to Stage 1 for aerodynamic lift during the boost phase, aft skirt with fins for Stage 1 flight controllability, and Thrust Vector Control (TVC) nozzle gimbal for steering during Stage 2 flight.

The INF Treaty requires accountability for any target configuration that uses existing or former ballistic missile assets. The TLV configuration uses two commercial motors which have no ballistic missile flight heritage and therefore do not fall within INF accountability requirements.

<u>6.1.2 Liquid Motor with RCS (Stage 3)</u>

The TLV third stage is a variant of the Pegasus XL Hydrazine Auxiliary Propulsion System (HAPS) consisting of a hydrazine velocity adjust system and a high-pressure nitrogen RCS. The primary functions of the hydrazine system are to eliminate the two-

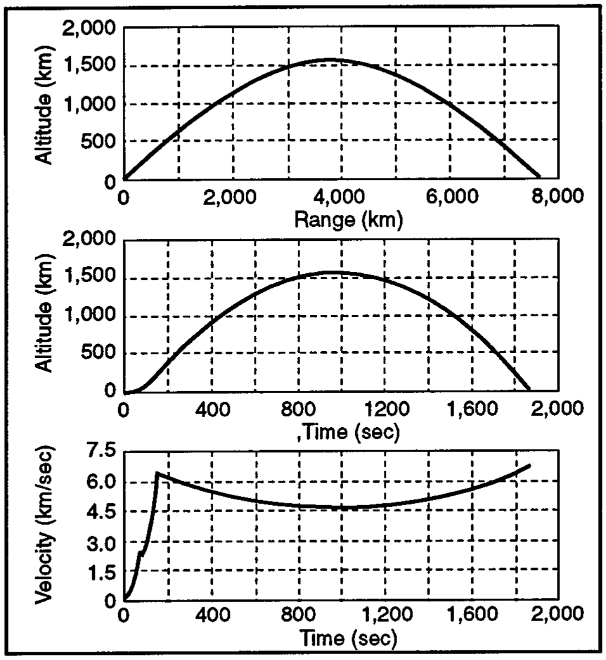


Figure 6. Orion 50 XL/50SXL 30 Degree Reentry Flight Path Angle.

stage motor dispersions to achieve the target intercept accuracy and booster/payload separation velocity requirements, and to provide maneuvering capabilities for the RV during reentry. The primary function of the nitrogen RCS system is to provide the necessary pitch, yaw, and roll orientation maneuvers for payload deployment and reradiation pointing requirements.

The velocity adjust requirements were estimated at ± 400 ft/sec (based on Orion 50XL/50SXL dispersion) to meet RV intercept location (± .02 deg) targeting restriction (range safety debris cloud). The HAPS system was also sized to accommodate any reentry maneuvering requirements. Through the use of typical Pegasus XL energy-scrubbing guidance schemes Stage 1/Stage 2 performance will be biased low to require 400 ft/sec ±400 ft/sec of nominal deltaV impulse (and up to 800 ft/sec worst case) to eliminate the requirement for vehicle attitude maneuvers during boost. Assuming a combined Stage 3/payload dry weight of 1,100 lbm and a delta V requirement of 800 ft/sec, the estimated propellant requirement is 130 lbm. The existing capacity of the HAPS system is 130 lbm in a blowdown mode and 160 lbm in a regulated mode.

Another configuration selection factor was the total Stage 3 burn time. Since mission profiles and deployment scenarios will vary, the desire is to minimize Stage 3 burn time to maximize payload deployment period. As shown in *Figure 7*, the blowdown system has the longest burn time associated with correcting the 800 ft/sec dispersion and may impact the deployment sequence timeline. If necessary, a regulated configuration could be used to increase average thrust to 153 lbf for a shorter duration (179 sec) to meet performance requirements while providing a longer deployment period.

Cold gas RCS system trades were based on 400 lbf-sec of total impulse required for 30 TLV post-boost phase deployment maneuvers and to control vehicle attitude within 10 degrees of the velocity vector for line-of-sight reradiation requirements. The existing RCS design capacity of 450 lbf-sec meets the current impulse requirement and can be readily increased by up to 50% through the addition of another pressurant tank or use of a larger tank should greater post-boost maneuvering be required.

6.1.3 Payload Shroud

The TLV 50" diameter shroud consists of two composite shell halves, nose cap, and separation system. The two halves are held together by titanium straps along the cylinder and a retention bolt in the nose. The shroud provides the payload and RV with the necessary volume and environmental protection to meet mission requirements. *Figure 8* shows the configuration including the candidate payload/RV configuration. The size, length, and diameter is identical to that of Pegasus to preserve the TLV "skin line" and eliminate the risk associated with a new

Stage 3 Requirement	Stage 3 Capability			
Delta V > 800 ft/sec (TLV + Payload ~ 1,100 lbm)	For 1,100 lbm TLV + Payload, 130 lbm N_2H_4 Propellant Required. Existing HAPS Blowdown Capacity Is 130 lbm; Regulated HAPS Capacity Is 160 lbm			
Minimize Stage 3 Burn to Remove Dispersions - Maximize Payload Deployment Sequence Time	**Thrust Level vs Burn/Deployment Time 130 lbm Fuel Load**			
	Configuration	**Average Thrust**	**Stage 3 Burn Time**	**Deployment Start Time**
	Blowdown/MR-107 Rocket Engine Assemblies	78 lbf	350 sec	550 sec
	Regulated/MR-107 Rocket Engine Assemblies	153 lbf	179 sec	379 sec
Maneuver Impulse > 400 lbf-sec (TLV Orientation/Deployments/ Attitude Control)	**Existing RCS Capacity Is 450 lbf-sec** Option #1: Additional Tank: 672 lbf-sec Option #2: Larger Tanks: 485 lbf-sec			

Figure 7. Stage 3 Analysis Results.

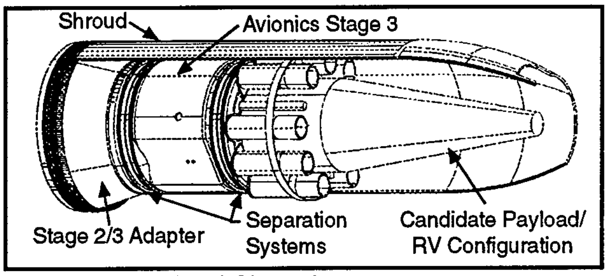


Figure 8. Payload Shroud.

aerodynamic profile during captive carry and powered flight.

The shroud and separation system was fully qualified through a series of structural, functional, and contamination ground tests and has been successfully flown on thirteen space launch missions.

6.1.4 Wing

The TLV wing uses a truncated delta planform with a double wedge profile. It has a central box structure with fittings at each corner which provide the structural interface between the TLV and CA. The wing was designed to provide 100% of the required boost phase lift as part of the space launch system (Stage 1 has a fixed nozzle). Since the wing provides the lift to sustain Stage 1 Flight, the TLV is in full compliance with the START treaty.

6.1.5 Aft Skirt

The TLV aft skirt assembly consists of aft skirt aluminum structure to protect the fixed Stage 1 nozzle, three composite fins, and the electromechanical fin actuators. The fins provide aerodynamic control and stability during Stage 1 flight. The aft skirt configuration has flown on twenty one space launch missions.

6.1.6 Avionics System

The TLV Avionics System consists of a Guidance and Control Assembly (GCA), Telemetry and Power Subsystem (TPS), Airborne Range Safety System (ARSS), 38" diameter support structure and two clampband separation systems. The system is an all-digital distributed processor design that implements TLV hardware, software and communications requirements during CA captive carry and powered flight. The majority of the hardware is housed on the avionics structure within the payload shroud with some electronics and ordnance located aft on the TLV solid motors. Mission assurance is achieved through the use of simple designs, high-reliability components, and extensive field site system level testing. The avionics design heavily leverages existing small launch vehicle designs and flight heritage.

The GCA is the heart of the TLV avionics system and includes a multiprocessor, 32-bit Flight Computer (FC). The FC communicates with the Navigation System Inertial Measurement Unit (IMU) and other vehicle subsystem using RS-422 digital serial data links. The FC executes its pre-programmed Mission Data Load (MDL) software through vehicle commanding and updates the flight profile based on vehicle performance. The MDL may employ General Energy Management (GEM) steering to target the intercept location. This architecture allows for integrated system level testing supporting mission assurance requirements. The GCA hardware has extensive flight heritage as part of twenty one space launch missions.

The TPS includes Modular Avionics Control Hardware (MACH) for vehicle power, health and status monitoring, and command outputs. The MACH system has the capability to initiate the up to 30 individual commands required for individual payload and RV deployment in addition to standard TLV booster requirements. The PCM encoder and telemetry RF portions of the TPS also support instrumentation data processing and reradiation of payload and RV deployment data.

The TLV ARSS supports ground-initiated command and autonomous on-board inadvertent stage separation destruct functions. The TLV flight profile will be designed to comply with all government range safety and telemetry acquisition requirements.

6.1.7 Flight Profile

The typical TLV flight profile shown in *Figure 9* is for a 850 lb payload at 30 degree reentry flight path angle into the KMR intercept location. The CA will drop the TLV at 39,000 ft and the first stage will ignite five seconds later. The TLV guidance system will initiates GEM maneuvers during Stage 1 and Stage 2 burn to minimize dispersions while maximizing performance. The Stage 3 will commence velocity adjustment liquid burn after Stage 2 burnout to reduce dispersions for intercept aimpoint targeting. Burn time is variable and will depend on the performance of the first two motors, effectiveness of the GEM maneuvers, and length of the mission-unique deployment scenario prior to intercept. If required, there may be a short coast period after the end of the ve-

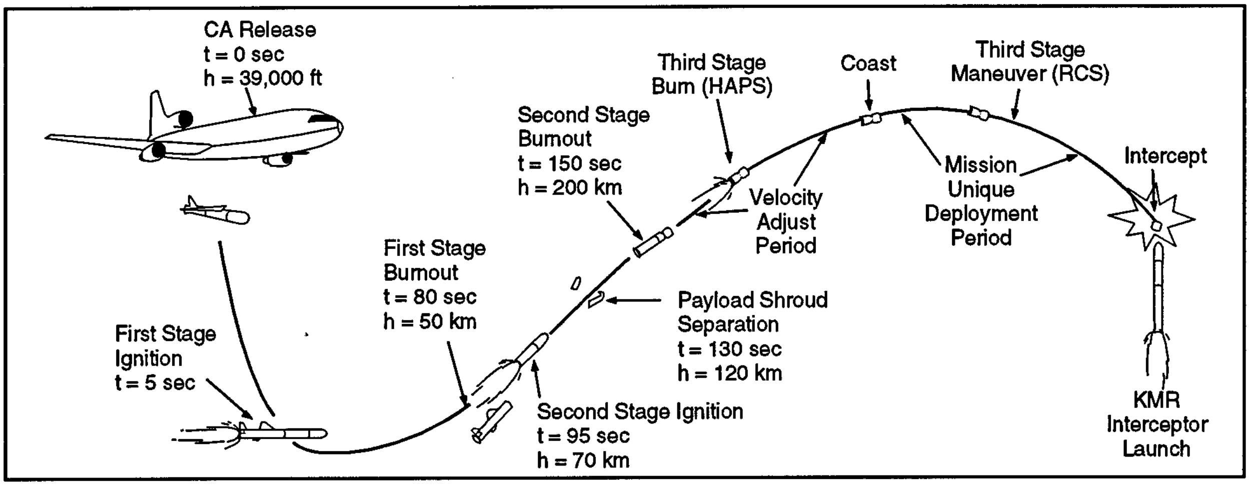


Figure 9. Typical TLS Flight Profile.

locity adjustment period before start of deployment maneuvers. The TLV will then initiate the Stage 3 cold gas system to begin the mission-unique deployment sequence and timeline to include pointing for reradiation of payload configuration data. Finally, the Stage 3 liquid system will perform any reentry vehicle maneuvering necessary prior to intercept at KMR.

6.2. TLS Carrier Aircraft

The TLS CA is a specially designed L1011 currently in service supporting the Pegasus Program. The aircraft was extensively modified from its original use as a commercial airliner and went through a thorough flight test program prior to supporting Pegasus launch operations. The CA interfaces will be identical to the Pegasus interfaces to support worldwide ferry flight operations while providing communications, air conditioning, and nitrogen payload services. The CA has on-board the Launch Panel Operator (LPO) station and two trained engineers performing vehicle monitoring and commanding as necessary during flight out to the launch point. See *Figure 10* for Compliance Summary.

The selected CA easily supports mission assurance requirements as demonstrated by its support of fifteen Pegasus launches. In addition, the aircraft is maintained in accordance with strict FAA rules and regulations further increasing its mission assurance. The FAA oversight allows the CA to land at a variety of airfields supporting launch and ferry operations. The CA is designed for efficient, safe, and responsive handling of any in-flight problems with minimum impact to the overall mission. The CA must file a standard Flight Plan for FAA approval prior to TLS operations. The on-board LPO telemetry monitoring system provides final TLV readiness prior to launch and supports Return-to-Base (RTB) operations if required.

Requirement	X	Comments
1. Mission Assurance	X	• CA Demonstrated Performance
2. Threat Representation	X	• Launch Point Mobility
3. Treaty Compliance		• N/A
4. Operational Flexibility	X	• Aircraft Fully Mobile
5. Range Restrictions	X	• File Flight Plan IAW FAA Restrictions

Figure 10. Carrier Aircraft Compliance Summary.

The ABM treaty constrains the interceptor launch to occur from KMR. The CA provides the launch location flexibility necessary to ensure the TLV flight profile supports a KMR intercept.

The CA is the key TLS component providing maximum flexibility to launch the TLV from almost any worldwide location. The CA is based at Bakersfield, CA to support Vandenberg Air Force Base (VAFB) operations and has already demonstrated its flexibility through four ferry flight operations, three to the East Coast of the US and one overseas to Spain. The CA has the range to fly to both TLV launch points (California and Alaska). The CA flight time constraint is two hours based on TLV rocket motor temperature limits. The CA requires standard aircraft support and has plenty of cargo space to carry TLV required support equipment to a remote location.

Government safety regulations require the TLV to be acquired from two independent range sources during the entire flight. In addition, the range command destruct system must have the ability to terminate TLV flight if necessary. The CA has the flexibility to modify its drop point to accommodate range coverage and safety restrictions.

6.3. Ground Support (GS)

Two major areas comprise the TLS Ground Support Segment: Facility Infrastructure (including GSE) and Range Support. See *Figure 11* for Compliance Summary.

Requirement	X	Comments
1. Mission Assurance	X	• Existing Facilities Available • WR, KMR TMD Testing Experience
2. Threat Representation		• N/A
3. Treaty Compliance	X	• KMR OK for Interceptor Launches
4. Operational Flexibility	X	• Navy P-3 Aircraft • KMRSS Assets
5. Range Restrictions	X	• Provides Required Coverage

Figure 11. Ground Support Compliance Summary.

6.3.1 Facility Infrastructure

The existing Pegasus Vehicle Assembly Building (VAB) located on VAFB provides all of the facility support necessary to process the TLV booster and payload hardware. The VAB is climate and contamination controlled and has standard industry power and shop air capabilities. The VAB has floor space to accommodate up to four vehicles at one time and has a portable clean tent to support integrated booster and TLV processing. There is also hazardous propellant loading area supporting HAPS liquid third stage processing. The existing VAFB airfield is located in close proximity to the VAB and supports all of the CA requirements to include runway length, power, and fueling capabilities.

6.3.2 Range Support

Range support is provided by the DoD Western Range (WR) for TLV ferry and flight operations for missions originating from VAFB until the vehicle goes over the horizon. KMR will provide support for TLV RV reentry maneuvers and payload pattern transmission. Launch operations originating from Elemendorf AFB, Alaska (EAFB) require a combination of Navy P-3 aircraft from Pacific Missile Range Facility (PMRF) for near-range support and Kwajalein Mobile Range Safety System (KMRSS) down-range capabilities. WR, KMR, and Navy P-3 Aircraft have a long, successful history of supporting numerous target launches in support of missile defense testing.

7.0 TLS OPERATIONS CONCEPTS

Operations concepts were established for each of the five mission scenarios using the selected TLS system design. *Figure 12* illustrates the mission scenarios.

7.1 Single Launch for Intercept

7.1.1 Launch Point West of California

The operation starts with arrival of the TLV and payload hardware at the VAFB VAB. The TLV and payload components are integrated and tested prior to transport to the VAFB airfield for mating to the CA. A series of integration tests with the TLV, CA, and GS range assets follows prior to final launch operations. The CA takes off with the TLV and flies to an altitude of 39,000 ft at Mach 0.8 in a racetrack pattern in preparation for launch. The CA releases the TLV to start its flight trajectory from a launch point 168 km southwest of VAFB. The CA returns to VAFB to prepare for the next mission. If an abort situation occurs, the CA has the capability to repeat part of the flight pattern for second attempt depending on the anomaly. If the problem cannot be corrected real-time, the CA will return to VAFB.

The TLV executes a westerly flight profile over the 7,317 km distance to the KMR intercept area. The vehicle uses GEM during Stage 1/2 burn in addition to the liquid third stage to reduce dispersions and target the intercept location. The WR tracks the vehicle throughout its boost-phase to meet range safety requirements. The RCS provides impulse for payload deployment for interceptor discrimination and the third stage maneuvers the RVs prior to actual intercept. KMRSS assets provide range safety support during the post-boost phase. The TLV reradiates the payload data to the KMR fixed range assets for real-time monitoring and post-mission reconstruction.

7.1.2 Launch Point South of Alaska

The operation has similar ground operations at the VAB and VAFB airfield prior to CA takeoff. The CA performs a ferry flight operation from VAFB to EAFB for refueling and routine aircraft maintenance. The CA flies to a point 200 km southeast of EAFB and launches the TLV. The CA then returns to EAFB to prepare for the flight back to VAFB.

The TLV executes a southwesterly flight profile over the 5,618 km distance to the KMR intercept area. The TLV executes all of the same events for this mission as for VAFB, with the exception of tailoring the RF transmission times to accommodate a different range support architecture. Navy P-3 aircraft are used for range safety and WR assets for telemetry acquisition during the boost phase with KMRSS and KMR fixed assets acquiring the TLV for payload and RV deployment events.

7.2 Multiple Engagement for Intercept

The multiple engagement scenarios require the addition of a ground-launched target from VAFB for high fidelity operational testing. The TLV can be launched from the California or Alaska launch locations depending on the test requirements. The TLV and CA operations concepts are identical to the single intercept missions in Section 7.1. In order to meet launch window and range support requirements, the TLV and ground target launch crews must coordinate their individual timelines to prevent launch delays.

7.3 Signature Acquisition Mission

This mission allows for exercise of the NMD detection and tracking assets only and does not include an intercept. The TLV and CA ground operations are identical to those for the Alaska launch point single intercept mission in Section 7.1.2 with a launch 200 km southeast of EAFB. In this case, the TLV executes a southeasterly flight profile over 2350 km to a location 400 km west of California. The TLV executes all of the same boost phase and payload deployment events to exercise NMD detection, radar acquisition and discrimination capabilities. Navy P-3 aircraft provide range safety support during the boost-phase with WR assets for down-range safety and TLV payload and RV deployment event acquisition.

8.0 CONCLUSIONS

Current TLVs available for NMD testing are necessary to properly test critical segments of the system architecture. However, the development of a long-range, mobile TLS is needed to complement the ground-launched targets and provide operational test support for NMD architecture readiness certification.

The selected NMD TLS concept provides the flexibility necessary to launch the TLV from multiple locations while complying with treaty considerations and range safety constraints. The TLS could operate independently or in conjunction with a ground-launched system for simultaneous multiple engagement scenarios.

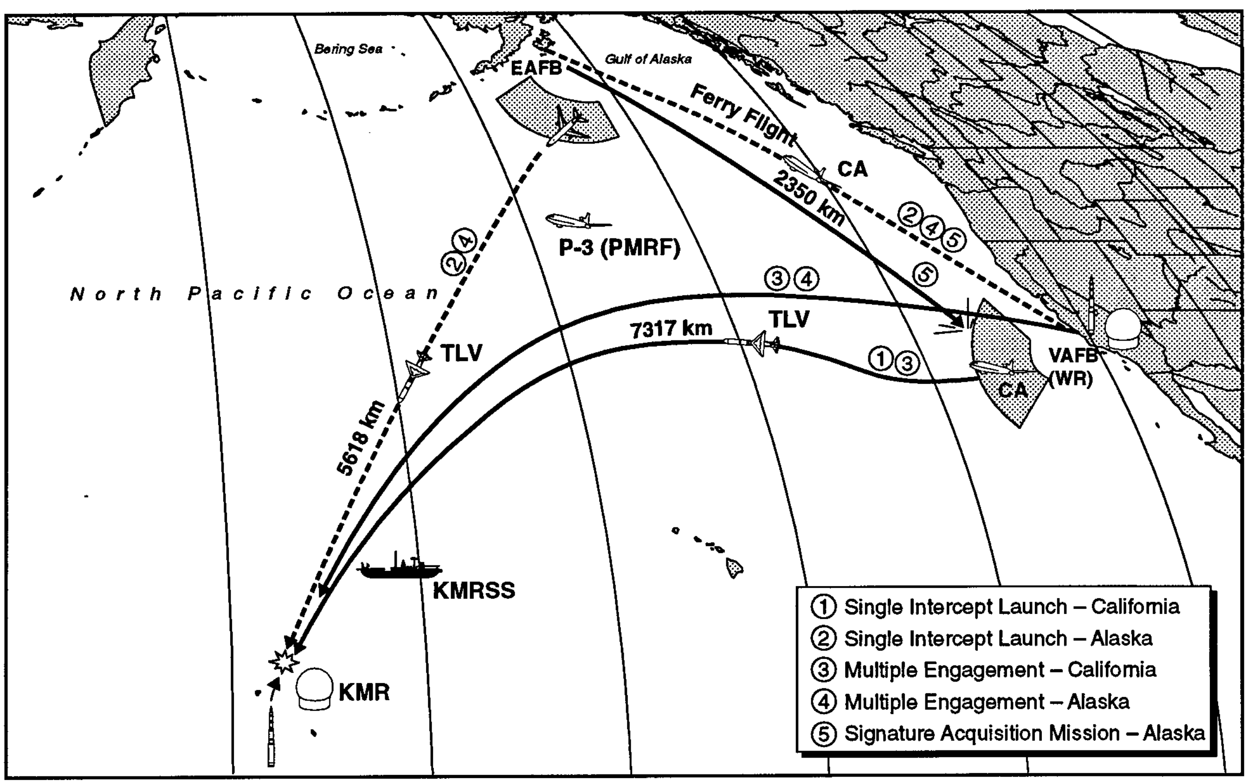


Figure 12. TLS Mission Scenarios.

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